

MATHEMATICS

N4 SYLLABUS

COORDINATOR: ENGINEERING STUDIES

NATIONAL CERTIFICATE

CODE NUMBER

1603164

DATE OF IMPLEMENTATION
January 2021

DATE OF FIRST. EXAMINATION



Contents

1. SUBJECT AIMS FOR MATHEMATICS N ₄	3
GENERAL SUBJECT AIMS	3
SPECIFIC SUBJECT AIMS	3
2. ADMISSION REQUIREMENT	4
3. DURATION OF COURSE	4
4. EVALUATION.....	4
5. EXAMINATION	5
6. GENERAL INFORMATION	5
7. SUBJECT MATTER.....	6
8. DETAILED SYLLABUS.....	7
8.1 MODULE 1: DETERMINANTS	7
LEARNING OUTCOMES.....	7
CONTENT.....	7
8.2 MODULE 2: COMPLEX NUMBERS	10
LEARNING OUTCOMES.....	10
LEARNING CONTENT	10
8.3 MODULE 3: TRIGONOMETRY.....	13
LEARNING OUTCOMES.....	13
LEARNING CONTENT	15
8.4 MODULE 4: SKETCH GRAPHS.....	16
LEARNING OUTCOMES.....	16
LEARNING CONTENT	17
8.5 MODULE 5: DIFFERENTIAL CALCULUS.....	18
LEARNING OUTCOMES.....	18
LEARNING CONTENT	20
8.6 MODULE 6: INTEGRATION.....	21
LEARNING OUTCOMES.....	21
LEARNING CONTENT	22



MATHEMATICS N₄ Syllabus

I. SUBJECT AIMS FOR MATHEMATICS N₄

1.1 GENERAL SUBJECT AIMS

Mathematics N₄ aims to provide learners with the skills to identify, and calculate mathematical problems in N₄ and the content form part of engineering calculation problems from industry.

Furthermore, Mathematics N₄ will equip students with relevant knowledge to enable them to integrate meaningfully into their trade subjects and also form the foundation for the N₅ – 6 syllabuses to finally achieve a National diploma.

Upon completion of this subject, the student should be able to apply

- 1.1.1 the necessary knowledge of Mathematics to various engineering fields in their respective working environments;
- 1.1.2 higher cognitive skills pertaining to application, analysis, synthesis and evaluation, logical and critical thought processes;
- 1.1.3 their understanding in the interpretation of real world problems;
- 1.1.4 and promote Mathematics as a tool to be used to trouble shoot in different fields of study.
- 1.1.5 certain theorems that are not examinable to be calculated.

1.2 SPECIFIC SUBJECT AIMS

- 1.2.1 The specific aims of Mathematics N₄ is to conclude pre- calculus and introduce differential and integral calculus thereby serving as a prerequisite for Mathematics N₅ and Mathematics N₆.
- 1.2.2 Mathematics N₄ strives to assist students to obtain trade-specific calculation knowledge.
- 1.2.3 Other specific aims of Mathematics N₄ also include:
 - 1.2.3 Promote correct mathematical terminology;
 - 1.2.4 Promote and focus on word problems and the problem solving thereof, in order to prepare the students for their relevant careers
 - 1.2.5 Use technology in Mathematics and apply Mathematics to further technology



MATHEMATICS N₄ Syllabus

2. ADMISSION REQUIREMENT

For admission to N4 Mathematics, a student must have passed

- a. grade 12 Pure Mathematics
- b. NCV level 4 Mathematics
- c. N3 Mathematics.

3. DURATION OF COURSE

The duration of the subject is one trimester on full time, part time or distance learning mode.

4. EVALUATION

Candidates must be evaluated continually as follows:

4.1 ICASS Trimester Mark

- 4.1.1 Assessment marks are valid for a period of one year and are referred to as ICASS Trimester marks.
- 4.1.2 A minimum of 40% is required for a student to qualify for entry to the final examination.
- 4.1.3 **Two** formal class tests for full time and part time students (or **Two** assignments for distance learning students only)

4.2 Calculation of trimester mark will be as follows:

- 4.2.1 Weight of test or assignment 1 = 30% of the syllabus
- 4.2.2 Weight of test or assignment 2 = 70% of the syllabus



MATHEMATICS N₄ Syllabus

5. EXAMINATION

- 5.1 A final examination will be conducted in April, August and November of each year.
The pass requirement is 40%.
- 5.2 The final examination shall consist of 100 % of the syllabus
- 5.3 The duration of the final examination shall be 3 hours
- 5.4 The final examination will be a closed book examination
- 5.5 Minimum pass percentage shall be 40%
- 5.6 Assessments shall be based on the cognitive domain of Bloom's Taxonomy, that is remember, understand, apply, analyse, evaluate, and create

The division of these aspects are as follows;

Remember	Understand	Apply	Analyse	Evaluate	Create
20	20	20	10	20	10

6. GENERAL INFORMATION

- 6.1 Problems should be based on real world scenarios allowing students to relate theory to practice.
- 6.2 Emphasis of correct mathematical terminology should be encouraged and promoted at all times.
- 6.3 A systematical approach to problem solving should be adhered to.
- 6.4 Students should be encouraged to understand rather than memorise the basic formulae applicable to N4 Mathematics.
- 6.5 Calculators may be used to do mathematical calculations.
- 6.6 Answers to all calculations must be approximated correctly to three decimal places, unless otherwise stated. Unless otherwise stated, approximations may not be done during calculations. The final answer must be approximated to the stipulated degree of accuracy.
- 6.7 The weight value of a module gives an indication of the time to be spent on teaching the module as well as the relative percentage of the total marks allocated to the module in the final exam examination (1 mark = 1.8 minutes).
- 6.8 **LEARNING CONTENT** are given at the end of each module. These guidelines provide relevant **Examples**, appropriate procedures and other pertinent information and may not be deviated from.



MATHEMATICS N₄ Syllabus

7. SUBJECT MATTER

Mathematics N4 strives to assist students to obtain trade-specific calculation knowledge.

Students should be able to acquire in-depth knowledge of the following content:

MODULE	WEIGHT VALUE
1. Determinants	(8)
2. Complex numbers	(12)
3. Trigonometry	(20)
4. Functions and Graphs	(10)
5. Differential Calculus	(25)
6. Integral Calculus	(25)
	[100]



8. DETAILED SYLLABUS

8.1 MODULE 1: DETERMINANTS

LEARNING OUTCOMES

On completion of this module, the student should be able to:

- 8.1.1 Convert equations with either two or three variables into a determinant.
- 8.1.2 Calculate second and third order determinants using row elimination, followed by application of Cramer's rule.
- 8.1.3 State and calculate the minor of a third order determinant.
- 8.1.4 Determine the co-factor of the minor.

CONTENT

SECOND ORDER

The determinant of a second order determinant $D = \begin{vmatrix} a & b \\ c & d \end{vmatrix}$ is $D = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$

Example

Evaluate D if $D = \begin{bmatrix} 6 & -3 \\ 2 & 3 \end{bmatrix}$.

$$D = \begin{bmatrix} 6 & -3 \\ 2 & 3 \end{bmatrix} = 6(3) - 2(-3) = 24$$

THIRD ORDER

The determinant of a third order determinant $D = \begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$ is

$$D = \begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = a(ei - fh) - b(di - fg) + c(dh - eg)$$



MATHEMATICS N4 Syllabus

Evaluate D if $D = \begin{bmatrix} 2 & 3 & -1 \\ 0 & 2 & 4 \\ -2 & 5 & 6 \end{bmatrix}$

$$\begin{aligned} D &= \begin{vmatrix} 2 & 3 & -1 \\ 0 & 2 & 4 \\ -2 & 5 & 6 \end{vmatrix} = 2 \begin{vmatrix} 2 & 4 \\ 5 & 6 \end{vmatrix} - 3 \begin{vmatrix} 0 & 4 \\ -2 & 6 \end{vmatrix} + (-1) \begin{vmatrix} 0 & 2 \\ -2 & 5 \end{vmatrix} \\ &= 2(2 \cdot 6 - 4 \cdot 5) - 3[0 \cdot 6 - 4(-2)] - [0 \cdot 5 - 2(-2)] \\ &= -16 - 24 - 4 \\ &= -44 \end{aligned}$$

$$D_x = \begin{vmatrix} x_1 & b & c \\ x_2 & e & f \\ x_3 & h & i \end{vmatrix} = x_1(ei - fh) - b(x_2i - fx_3) + c(x_2h - ex_3)$$

Kramer's rule:

$$x = \frac{D_x}{D}$$

Minor:

If D is a determinant $D = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}$ then the minor of any element in D is obtained by

eliminating the row and column in which that element appears.

Example

$$\text{Minor of } 3 = \begin{vmatrix} \cancel{2} & \cancel{3} & \cancel{1} \\ 0 & 2 & 4 \\ -2 & 5 & 6 \end{vmatrix} = \begin{vmatrix} 0 & 4 \\ -2 & 6 \end{vmatrix} = 0(6) - 4(-2) = 8$$

Cofactor:

The cofactor of an element is the minor multiplied by 1 or -1. The cofactor is determined where the element appears in the following table of signs.



MATHEMATICS N₄ Syllabus

$$\begin{bmatrix} + & - & + \\ - & + & - \\ + & - & + \end{bmatrix}$$

Example

Since 3 has minor 8, with the corresponding sign which is negative, the cofactor of 3 is -8.

8.2 MODULE 2: COMPLEX NUMBERS

LEARNING OUTCOMES

On completion of this module, the student should be able to:

- 8.2.1 Define an imaginary number.
- 8.2.2 Identify real and imaginary parts of a complex number rectangular form.
- 8.2.3 Simplify complex powers
- 8.2.4 Add, subtract, and multiply complex numbers in rectangular form
- 8.2.5 Define and determine the conjugate of a complex number.
- 8.2.6 Divide complex numbers in rectangular form using the conjugate.
- 8.2.7 Define the modulus and argument of the complex number and plot them on an Argand diagram
- 8.2.8 Convert a complex number from rectangular to polar form and vice versa, using a pocket calculator or any analytical method.
- 8.2.9 Multiply and divide complex numbers in polar form
- 8.2.10 State and apply De Moivre's theorem to products, quotients and powers of complex numbers.
- 8.2.11 Solve complex equations in rectangular or polar form

LEARNING CONTENT

We define a number $i = \sqrt{-1}$ (NOTE also $j = \sqrt{-1}$) as purely imaginary

A **complex number** is an expression of the form $a + bi$, where a and b are real numbers and $i^2 = -1$. The **real part** of this complex number is a and the **imaginary part** is b . Two complex numbers are **equal** if and only if their real parts are equal and their imaginary parts are equal. Note that both the real and imaginary parts of a complex number are real numbers.



MATHEMATICS N4 Syllabus

Example

The following are examples of complex numbers.

$$3 + 4i \quad \text{Real part 3, imaginary part 4}$$

$$\frac{1}{2} - \frac{2}{3}i \quad \text{Real part } \frac{1}{2}, \text{ imaginary part } -\frac{2}{3}$$

$$6i \quad \text{Real part 0, imaginary part 6}$$

$$-7 \quad \text{Real part } -7, \text{ imaginary part 0} \quad \blacksquare$$

A number such as $6i$, which has real part 0, is called a **pure imaginary number**.
A real number like -7 can be thought of as a complex number with imaginary part 0.

Each complex power can be resolved into one of the following solutions 1 ; -1 ; i ; $-i$ and the higher complex powers are derived from these.

Example

$$i = i$$

$$i^2 = -1$$

$$i^3 = -i$$

$$i^4 = 1$$

Example

$$\text{Addition and Subtraction: } (a + bi) \pm (x + yi) = (a \pm x) \pm (b + y)i$$

$$\text{Multiplication: } (a + bi)(x + yi) = (ax - by) + (ay + bx)i$$

Example

If $z = x + yi$ then z has a conjugate $\bar{z}$ which we define as $\bar{z} = x - yi$. In particular

$$z \cdot \bar{z} = (x + yi) \cdot (x - yi) = x^2 + y^2 \text{ which is instrumental for division.}$$

Example

$$\text{Division: } \frac{a + bi}{x + yi} = \frac{(ax - by) + (ay + bx)i}{x^2 + y^2}$$

Example

If $z = x + yi$ then we define the polar form of z as $z = r(\cos \theta + i \sin \theta)$ where r is called the modulus and θ is called the argument. Furthermore,



MATHEMATICS N4 Syllabus

$$\begin{aligned}z &= r(\cos \theta + i \sin \theta) \\&= r \operatorname{cis} \theta \\&= r \angle \theta\end{aligned}$$

r is obtained by using the identity: $r = \sqrt{x^2 + y^2}$ and similarly for θ , $\theta = \arctan\left(\frac{y}{x}\right)$ An

argand diagram is obtained by using normal Cartesian coordinates. On this plot, the line has to be shown with its coordinates, modulus, and argument. The plot is limited to at most two sketches consisting of a function z and its conjugate $\bar{z}$. The above strategy may be calculated using a scientific calculator to determine the modulus and arguments for more difficult functions.

Example

For polar form calculations we obtain the following: let

Multiplication: $(a + bi)(x + yi) = (r_1 \angle \theta_1) \cdot (r_2 \angle \theta_2) = r_1 \cdot r_2 \angle \theta_1 + \theta_2$

Division: $\frac{a + bi}{x + yi} = \frac{r_1 \angle \theta_1}{r_2 \angle \theta_2} = \frac{r_1}{r_2} \angle (\theta_1 - \theta_2)$

where, $z_1 = a + bi = r_1 \angle \theta_1$ and $z_2 = x + yi = r_2 \angle \theta_2$

Application of **De Moivre's theorem:** $z^n = (x + yi)^n = (r \angle \theta)^n = r^n \angle n\theta$

Students will be required to solve complex equations by using the quadratic equation and this solution will have a real and imaginary part.



8.3 MODULE 3: TRIGONOMETRY

LEARNING OUTCOMES

On completion of this module, the student should be able use their previous knowledge of trigonometry and apply it to

8.3.1 Calculate Special Triangles pertaining to the four quadrants.

the concept of negative and positive angles to all the calculations relevant to this syllabus.

8.3.2 the notion of compound angles such as $\sin(a \pm b)$, $\cos(a \pm b)$, and $\tan(a \pm b)$.

The complementary angles specifically to trigonometric identities

Factorisation of different types of trigonometric equations including using identities

8.3.3 The derivation of the following identities:

Compound angles

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B;$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B;$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

Double angles

$$\sin 2a = 2 \sin a \cos a;$$

$$\cos 2a = \begin{cases} \cos^2 a - \sin^2 a \\ 2 \cos^2 a - 1 \\ 1 - 2 \sin^2 a \end{cases}$$

$$\tan 2a = \frac{2 \tan a}{1 - \tan^2 a}$$



MATHEMATICS N4 Syllabus

Half angles

$$\sin \frac{1}{2}a = \sqrt{\frac{1}{2}(1 - \cos a)};$$

$$\cos \frac{1}{2}a = \sqrt{\frac{1}{2}(1 + \cos a)}$$

$$\tan \frac{1}{2}a = \sqrt{\frac{1 - \cos a}{1 + \cos a}}$$

$$\sin^2 a = \frac{1}{2}(1 - \cos 2a)$$

$$\cos^2 a = \frac{1}{2}(1 + \cos 2a)$$

8.3.4 derive the co-ratios $\sin(90^\circ \pm \theta)$; $\cos(90^\circ \pm \theta)$ and $\tan(90^\circ \pm \theta)$

8.3.5 the square, invert and quotient identities, and furthermore solve trigonometric equations, simplify trigonometric expressions and prove trigonometric identities.



LEARNING CONTENT

Example

If $\sin A = \frac{1}{2}$, where $A \in [-360^\circ; 360^\circ]$ then $A = 30^\circ$ or 150° or -210° or -330°

Example

Determine $\tan(-75^\circ)$ without the use of a calculator

If $\sin A = -\frac{3}{5}$, and $\cos B = \frac{1}{2}$ where A and B are complementary angles.

Determine: without the use of a calculator

$$\tan(A \pm B)$$

$$\cos(A \pm B)$$

$$\sin(A \pm B)$$

Example

Solve for x on some interval

$$\sin 2x - \cos x = 0,5$$

$$\sin(x + 30^\circ) = \cos(x + 82^\circ)$$



8.4 MODULE 4: SKETCH GRAPHS

LEARNING OUTCOMES

8.4.1 distinguish between a dependent and an independent variable

8.4.1.1 define a domain and range

8.4.1.2 state the difference and distinguish between functions and relations

8.4.1.3 identify the relevant functions that relate to their graphs

8.4.1.4 points of symmetry with reference to an axis or the lines $y = \pm x$

8.4.1.5 inverse functions and relations

8.4.2 Draw neat sketch graphs of the following functions/relations. Only critical values need to be indicated. No table of values or point for point plotting is required. Critical values may, where possible, be calculated with the aid of differentiation, after the module on differentiation has been completed.

8.4.2.1 $ax + by + c = 0$

8.4.2.2 $x^2 + y^2 = r^2$; $y = \pm\sqrt{r^2 - x^2}$; $x = \pm\sqrt{r^2 - y^2}$

8.4.2.3 $xy = c$

8.4.2.4 $\frac{x^2}{a^2} \pm \frac{y^2}{b^2} = 1$

8.4.2.5 $y = ka^{nx}$, $y = ke^{nx}$, $y = k\log_a(nx)$ and $y = k\log_e(nx)$

$y = ka^{nx}$, with $a > 1$ and a and n positive integers

$y = ka^{nx}$ with $0 < a < 1$ rational and n a positive integer

$y = k\log_e(nx)$ with n a positive integer

$y = k\log_a(nx)$ with $a > 1$ and a and n positive integers

$y = k\log_a(nx)$ with $0 < a < 1$ rational and n a positive integer

8.4.2.6 $y = a\sin(bx + c) + d$;



MATHEMATICS N4 Syllabus

$$y = a \cos(bx + c) + d; \text{ and}$$

$$y = a \tan(bx + c) + d, \quad \text{for } -\pi \leq x \leq \pi$$

8.4.2.7 $y = \operatorname{cosec} x$

$$y = \sec x$$

$$y = \cot x$$

$$\text{for } -\pi \leq x \leq \pi$$

8.4.2.8 $y = ax^2 + bx + c$

8.4.2.9 $y = ax^3 + bx^2 + cx + d$ where a, b, c and d are integers

LEARNING CONTENT

Example

Sketch the graph of $y = 3 \cdot 2^x$

Is this a function or relation?

State the domain and range of y ?

determine the equation of the inverse of y in the form $f^{-1}(x) = \dots$

Sketch y and $f^{-1}(x)$ are the same system of axis indicating all relevant points of intersections.

Is y continuous at $y = 0$?

About which line is y asymmetric



8.5 MODULE 5: DIFFERENTIAL CALCULUS

LEARNING OUTCOMES

On completion of this module, the student should be able to:

8.5.1 Calculate limits that are indeterminate:

$$\frac{0}{0} \text{ and } \frac{\infty}{\infty}$$

by making use of algebraic expressions and quotients. (The theorem of L'Hôpital may not be applied).

8.5.2 use the binomial theorem in general terms.

8.5.3 Apply the binomial theorem with rational indices to expand a simple binomial to four terms.

8.5.4 Define differentiation as a rate of change and derive the expression

$$\lim_{\Delta x \rightarrow 0} \frac{f(x + \Delta x) - f(x)}{\Delta x} \text{ or } \lim_{h \rightarrow 0} \frac{f(x + h) - f(x)}{h}$$

from first principles with the aid of a sketch as an introduction to differentiation. $f(x)$ may only be in one of the following forms: $f(x) = ax^n + b$ with $ax^n + bx^{n-1} + cx^{n-2} + \dots$ and n a positive integer. A student may **ONLY** be examined for n A STRICTLY POSITIVE NATURAL NUMBER LESS THAN 4.

8.5.5 Determine dy/dx of the following standard forms:

$$y = k$$

$$y = kx^n$$

$$y = ka^x$$



MATHEMATICS N4 Syllabus

$$y = k e^x$$

$$y = k \ln x$$

$$y = k \log_a x$$

$$y = k \sin x$$

$$y = k \cos x$$

$$y = k \tan x$$

$$y = k \cot x$$

$$y = k \sec x$$

$$y = k \operatorname{cosec} x$$

8.5.6 Apply the chain rule to determine the first derivatives of

$k a^{nx}$; $k e^{nx}$; $k \log_a n x$; $k \log_e n x$; $k \sin (bx)$; $k \cos (bx)$; $k \tan (bx)$; $k \sec (bx)$; and $k \operatorname{cosec} (bx)$.

8.5.7 Apply the product and quotient rules for differentiation of differentiate simple products and quotients. Combinations of chain, product and quotient rules may not be asked.

8.5.8 Determine the second derivatives of trigonometric functions, algebraic terms and polynomials to determine maximum and minimum turning points and points of inflection for the functions in this syllabus.

8.5.9 Sketch graphs indicating maximum and minimum values derived in 8.5.8



LEARNING CONTENT

Example

Complete definitions of factorial notation must be given as well as the binomial pattern discovered experimentally by multiplication.

$$(a + x)^n; n = 1; 2; 3; 4; 5; \dots \text{etc}$$

Example

Expand and simplify $(2x - 3y)^6$ up to four terms.

$$\begin{aligned}(2x - 3y)^6 &= (2x)^6 + 6(2x)^5(-3y) + \frac{6 \cdot 5(2x)^4(-3y)^2}{2!} + \frac{6 \cdot 5 \cdot 4(2x)^3(-3y)^3}{3!} + \dots \\ &= 64x^6 - 576x^5y + 2160x^4y^2 - 4320x^3y^3 + \dots\end{aligned}$$

Example

Differentiate $3x^3$ from first principles

Example:

Differentiation techniques:

Chain rule: $\sin 2x$

Product rule $y = x \ln x;$

Quotient rule $y = \frac{e^x}{\ln x}$



8.6 MODULE 6: INTEGRATION

LEARNING OUTCOMES

- 8.6.1 Understand the concept of integration as a summation function (definite integral) and as a process of anti-differentiation (indefinite integral).
- 8.6.2 Apply standard forms of integrals as a process of anti- differentiation
- 8.6.3 Integrate functions given on the formula sheet
- 8.6.3.1 kx^n , n real with $n \neq -1$
- 8.6.3.2 $\frac{k}{x}$; ka^{nx} ; ke^{nx} ; with $a \geq 0$, $k, n \in \mathbb{R}$
- 8.6.3.3 $k \sin(bx)$ and $k \cos(bx)$ with b and $k \in \mathbb{R}$
- 8.6.4 Integrate polynomials consisting of terms of the above forms
- 8.6.5 Apply integration to determine the magnitude of an area included by a curve and the X-axis, or by a curve, the X-axis and the ordinates $x = a$ and $x = b$, where a and b are integers. The graphs are limited to those given in Module 4 and those functions that can be integrated with N4 knowledge of integration.
- 8.6.6 Using the definite integral with two limits to calculate the area bounded by the graph, the x – axis and values given to define the area. Areas include areas above the x – axis, areas below the x – axis and joined areas above and below the x axis.

$$A = \int_a^b y dx \text{ or } A_{total} = \int_a^b y dx + \int_c^d y dx$$

- 8.6.7 Calculate intersection points of two curves, and sketch the two graphs on the same system of axis indicating the area bounded by the two intersection points calculated and show the representative strip used to calculate the area.



LEARNING CONTENT

The function and representative strip shall be limited to $y = f(x)$ and will be along the direction of Δx only. $x = f(y)$ and Δy is not applicable nor examinable in this syllabus.

Examples

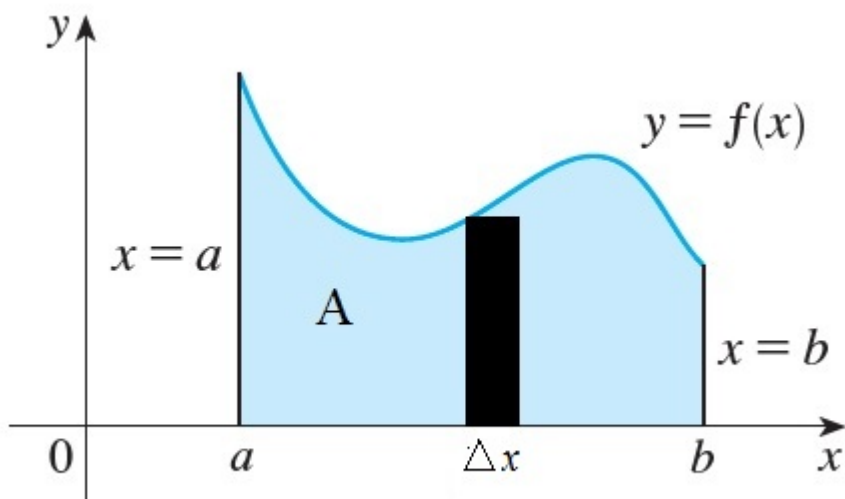
Integrate the following

$$\int \left(\frac{\cos^3 x - 1}{\cos^2 x} + e^{2x} + \ln e^{3x} + \sin 2x + \pi^x + 5^{7x} \right) dx$$

Examples

A neat rough sketch of the relevant curve must be drawn and the area to be found clearly indicated. The representative strip dx , and the limits of the area must be indicated.

Case1: Area bounded on an interval

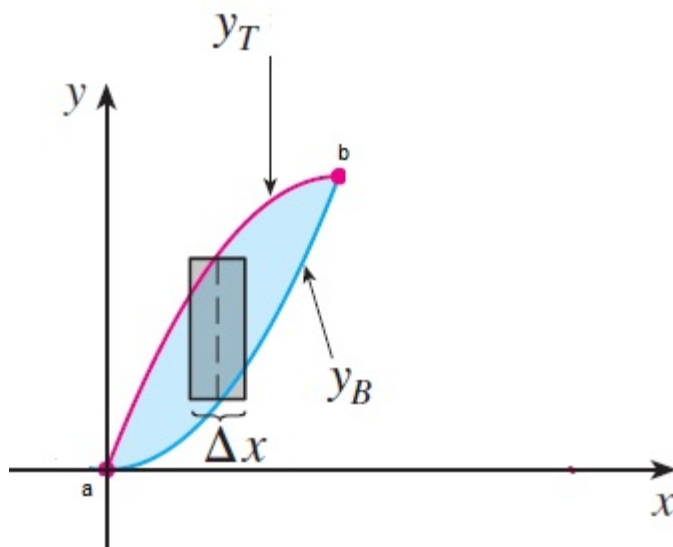


For a single curve bounded on an interval, the area must be represented as $A = \int_a^b y dx$



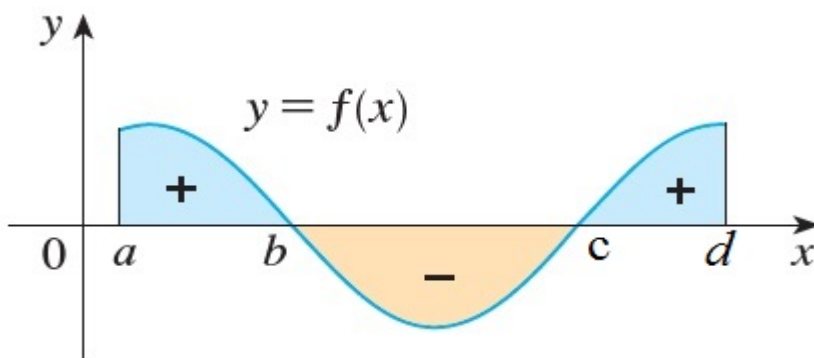
MATHEMATICS N4 Syllabus

Case 2: Area bounded between two curves



The area bounded by the intersection of two curves are given as $A = \int_a^b (y_T - y_B) dx$ The total area must then be written down in the form of the correct definite integral.

Case 3: The area may as a whole be above the X-axis or below the X-axis or partly above and partly below the X-axis



In this case the *total net* Area is given as $A = \int_a^b f(x) dx - \int_b^c f(x) dx + \int_c^d f(x) dx$